Embodiment

To us, embodiment and embodied learning are all about communication and connection; communication with oneself, with others and with the world.

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Embodiment

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Introduction

Karien Vermeulen - head of programme Waag Society

Nowadays it seems we are all about the head, mind and eyes: our world is dominated by screens and in education, children are requested to sit still behind their desk and are constantly asked to use their heads - without being able to move and use their body.

But as cognitive science has discovered compelling evidence that nearly all of our experiences - everything we do and learn - are in some way grounded in the body, you could ask if that is the way to go. We know that we perform better when we are comfortable in our skin. We know that we feel better when we connect to and understand our body. So why do we neglect this body of ours so often in our work, our learning processes and in the technological applications that are being developed? And, what can we do to make a change?

The British medical doctor, neuroscientist and engineer Daniel Wolpert even takes it as far as to state that the real reason we even have a brain is to produce adaptable and complex movements. Not to think or to perceive the world, no: to move. According to Wolpert, moving is the only way to actually affect the world around you.

Such observations triggered Waag Society a few years ago to focus more on the body in our development of technological applications in general and in our Creative Learning Lab programme more specifically. Rapid technological developments in low cost sensor and biofeedback technology facilitate our research.

We are inspired by, amongst others, Merleau-Ponty's research on the (use of) the body as being a permanent condition for experience and John Dewey's theories on the importance of the body-mind connection in learning processes. More recently we drew lessons from the experiences of SMALLab Learning and for instance social psychologist Amy Cuddy's research on power posing.

We have developed several prototype installations, in cooperation with our partners of the COMMIT consortium, with Kennisnet and through the valuable residency of artist Marloeke van der Vlugt at Waag Society. This booklet represents the display of the results of our applied research.

- NumHop taught us about the use of multi-sensor interactive systems for embodied learning games.

- Superhero Island 1.0 and 2.0 allowed us to explore the use of the body within a more formal educational setting and in relation to learning preferences.

- The Mood Room has given us insights on cognitive and affective empathy, wordless emotional communication and sensory experiences.

- Cylinder-Rolling Stairs-Seesaw has taught us about balance, the importance of haptic and tactile objects, corporal literacy and natural interaction with technology.

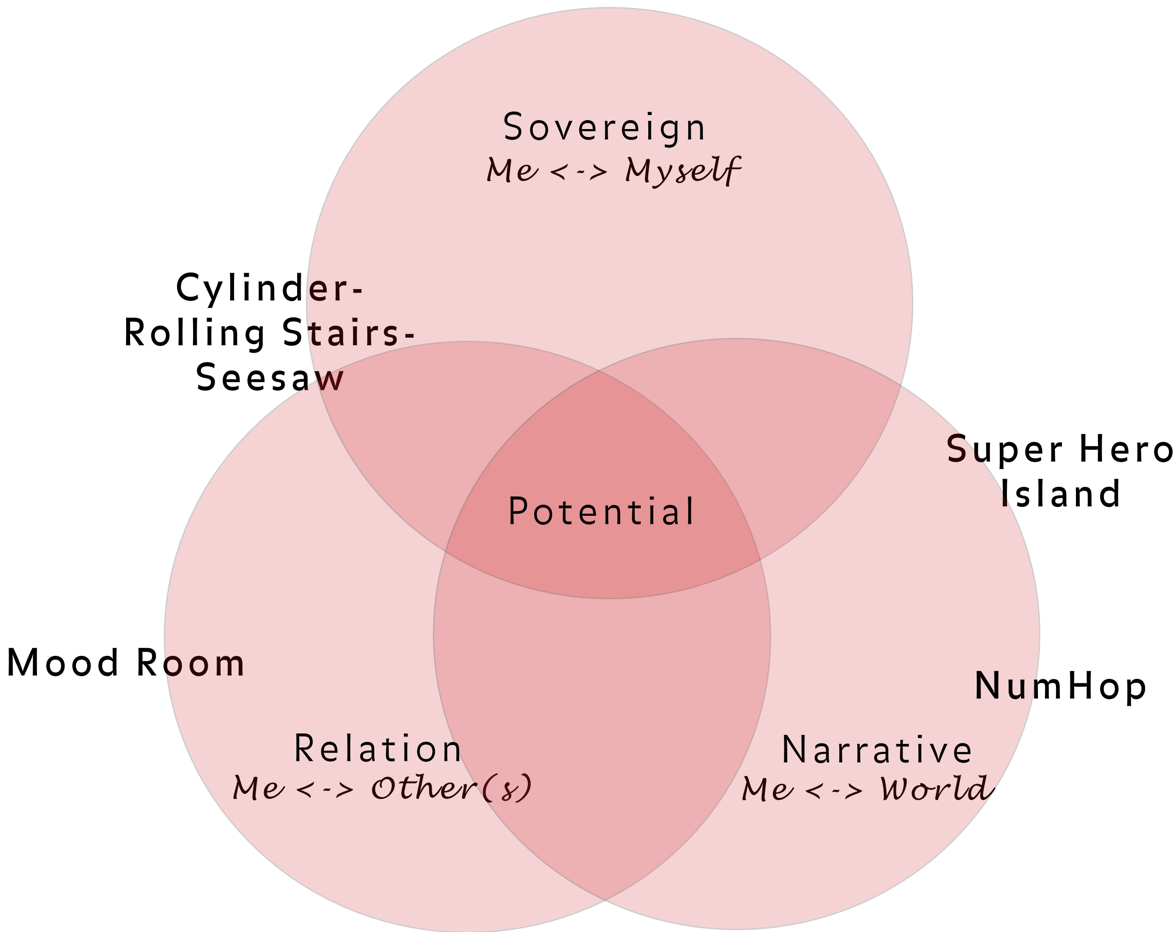
More in depth findings are presented in the articles of my colleagues in the next chapters of this booklet.

To us, embodiment and embodied learning are all about communication and connection; communication with oneself, with others and with the world. Waag Society's ultimate goal is to empower people by means of technology, in order for them to be able to give meaning to their environment and shape their own life.

In our projects and designs, we aspire to meet four criteria that, in conjunction, represent elements of 'the good life' - given the fact that our primary physiological and safety needs are being satisfied.

- Sovereignty; being able to maintain control over one's personal life.
- Relation; being able to enter into meaningful relationships with others.
- Narrative; being able to belong to a larger narrative, to find a meaningful place in the world, resulting in lasting behavioural change.
- Potential; being able to explore, fully live up to and fulfil one's potential.

In combination, we identify different dimensions of embodiment that schematically form the provisional model below and allow us to map our activities.



Our research on embodiment so far has resulted in the following requirements for embodied technology:

- Haptic; the design should be tactile and physically challenging.
- Intuitive; the design should address readily transferred, existing skills and is memorable, discoverable, and matches expectation.
- Bodily feedback; the design should help create focus and attention and/or provide feedback and reflection on one's own body.
- Multisensory; the design should dynamically appeal to different senses.
- Human scale; the design should reflect the subjective reality of the individual as the measure of all things.
- Transfer; the design should enable the user to be creative to add something and to personalize it.

This list is not extensive, but still in flux, and we will continue our experimental research on embodiment and communication. We extend our activities to biofeedback mechanisms: we will for instance mirror neurons and start with applied research experiments on neurotechnology and learning, in cooperation with our artistic, academic and educational partners.

It's a work in progress; so if you have questions, feedback, suggestions or examples you would like to share, please keep us posted.

For now, we wish you pleasant reading. Upon which we advice you to stand up immediately, move, stretch and balance.

Exploring embodied learning

Meia Wippoo - concept developer Waag Society

Introduction

For several years Waag Society has been observing the Dutch education field, and has been introducing new technologies and methods into this field to get learning and teaching ready for the 21st century. Technology in schools might have had the stigma of just 'sticking kids behind a computer' and creating little change in the curriculum and the way things are taught. These days however, technological developments make it possible to make changes in the way we educate, in the way we present a curriculum. Following these developments Waag Society has been researching one of the most promising themes in education in years: embodied learning.

A common view in the educational field contains the notion that learning is something that only occurs by using our head. But:

Despite the common perception that knowledge resides above the neck, I find my entire body is the repository for all that I know.[1]

Previous to this quote, Stinson[2] argues that the inside/outside interaction, the connection between what is in the world and how we feel and think about it (in the broadest sense), is often neglected in education. Yet, this internal sensing has great significance for not only how we perform but also how we perceive, and with that, how we learn and remember.

Cognitive scientists have discovered compelling evidence that nearly all of our experiences are in some way grounded in the body. This suggests that the embodied experiences can lead to more effective learning.[3]

This 'learning with your whole body' has been called 'embodied learning'. The hypothesis that your body plays a significant part in learning opens up a world of opportunities, both in education and in (the use of) technology.

But it is also a very complex field of research, with many ways of interpretation. To get a clear sense of what is out there, and to define what we would consider 'embodied learning', we need some story of origins. And with that, present a view of our own on the topic. The following will try to achieve just that.

Embodied cognition

The notion of 'embodied learning' is an extension of theories around embodied cognition, a rather radically new view in psychology that connects physical acts and experiences to cognitive processes. Research in embodied cognition show that cognitive processes, like understanding language and memorizing, are heavily influenced by embodied experiences. This would mean that the part the brain plays in the cognitive process is different from what we used to think; instead of having to represent knowledge about the world and using that knowledge to send out commands to the rest of the body, the brain is now part of a broader system that involves perception and action also.

To illustrate this: it is easier to understand 'language' when performing a physical activity during language development. Arthur Glenberg, renowned psychology professor at the Universities of Wisconsin and Arizona State, researched two groups of children. The group reading a story and then depicting the scene with toys did better in comprehending the text than the control group who just read the text twice.[4] This brings us to 'embodied learning'.

Embodied Learning: the body communicates

'Embodied learning' is still a very uncharted terrain, and many things could be annexed by this term. In order to develop and design effective applications it needs to be further defined beyond 'learning with your whole body'. Mina Johnson-Glenberg, one of the first to research 'embodied learning' in relation to technology with the project SMALLab, acknowledges this need:

1 Stinson, S.W. (2004). My Body/Myself: Lessons from Dance Education. In: Bresler, L. (Ed.), Knowing bodies, moving minds. pp. 153-168.
2 Stinson, S. (1995). Body of knowledge. Educational Theory, 45(1), 43-54.
3 www.smallablearning.com/embodied_learning

4 Glenberg, A. M., Gutierrez, T,, Levin, J. R., Japuntich, S., & Kaschak, M. P. (2004). Activity and imagined activity can enhance young children's reading comprehension. Journal of Educational Psychology, 96, 424-436.

[...] it has different meanings for different stakeholders. For learning scientists, it has a very specific meaning: comprehension and retention are affected by sensory motoric input. At SMALLab Learning, we create educational content that taps into embodied learning using the latest advances in motion capture technology.[5]

Waag Society also follows this defining road SMALLab Learning has mapped. But we could elaborate a little bit more.

For starters, it is important to state that embodied learning discusses the relation between learning, a cognitive process, and use of the body as a vessel to acquire knowledge. This seems rather straightforward, but it covers a wide variety of use of this 'vessel'. In this context the body should be viewed as a means of communication between the outside world and the mind, and it understands many 'languages'.

Sensory experiences
Some of these 'languages' the body uses are sensory experiences (smell, taste, sound, touch, vision, etc.). They are essential in saving and processing new information. Touching a soft bunny for the first time is a sensory and therefore a physical experience. This sensation occurs in your hands - and is registered in your neurological system. This is a sensation that will stay with you, possible coupled with a visual or smell. The next time you feel, see or smell the same or a similar thing, you are able to recall the sensations you felt before.

Brain areas associated with long-ago learned concepts are still activated when humans think about those concepts or even those tools. Pulvermüller found that when participants simply read the word for an action, the motor system became activated to represent its meaning. He illustrated this with the similar sounding and looking words 'lick', 'pick' and 'kick' respectively triggering areas in the brain related to facial, arm and leg connected actions.[6]

In many cases these are not conscious processes. It is assumed that when movement, smell or sound is repeated, the memories of the previous knowledge relating to these sensations are automatically called upon. You don't need to be actively aware of the fact that a smell, sound or feeling could be linked to an experience.

The physiological process is the same for storing and remembering the experience - it activates the same part of the brain - so there is no active storing and recalling process needed to link the two.
Empathic processes can also be attributed to sensory experiences. For example: you understand heartbreak, because you've been through it, and therefore you know which physical and mental effects are related to that feeling.

Motor experiences
On the other hand there are 'languages' the body uses that are connected to motor skills and active movement by the body. You could say that in some cases the body serves as a 'controller'. A person can, consciously, steer a learning experience by using the body. It is assumed that just by being active, by using your body, it is easier to remember things, even when there is no immediate relation between the movement and the content or information.

Mixing experiences
The body can understand multiple 'languages' at the same time. A person can be consciously aware of the fact he or she is moving around while solving a puzzle, and at the same time be unaware of the fact that he or she is smelling the scents of a forest and feeling the chill in the air and the sun on their face, sensations now coupled with a memory of a spring walk - and now also coupled with solving a puzzle.

'Embodied learning' might therefore be used in formal educational contexts, like in learning a language or doing sums, but also in the more abstract learning situations like dealing with stress, sharing feelings and understanding emotions.

Working towards the education system
'Learning with your whole body' is actually not a very new concept. In 1934, Dewey already stressed the importance of the body-mind connection; that it is not simply the acknowledgement of the sensory input that goes to the brain, but that it is based upon the interaction of subject within a complex and challenging environment.[7] More recent studies provide affirmation of Dewey's belief that it is the body and its interaction with the environment that serves as the basis of knowing.[8] Following this logic you could argue that playing (outside) in the playground is some form of 'embodied learning'. While playing, children use their entire body and they develop cognitive and physical skills that are useful for the rest of their lives.

5 Mina Johnson-Glenberg - http://smallablearning.com/how-embodied-learning-can-help-students
6 Pulvermuller, F. (2005). Brain machanisms linking language and action. Nature Reviews Neuroscience 6, 576-582

7 Dewey, J. (1934). Art as experience. New York: Capricorn Books.
8 Damascio, 1999.

By introducing the principle of 'embodied learning' in educational and didactical research, and by connecting these findings to new and accessible technology there are now new opportunities to experiment with the didactics and the way we address and challenge children.

Embodiment and formal education
Formal education can be described as the general educational subjects covered in schools like language and mathematics, but also geography, biology and history. So far these formal subjects are taught in formal school settings. Introducing embodied learning in a formal school situation will change the latter.

'Embodied learning' is challenging the formal educational form of presentation in plenary instructions, little differentiation in levels of subject, and children generally sitting in rows or groups, behind desks - designed to accommodate developing 'knowledge above the neck'. Up to now, children are allowed to walk around only during very few subjects, mostly the 'playful' classes such as art and physical education. But there is much to be said for a change in these settings.

If the physical movement primes (readies) other constructs (like language), then learning via movement may add an additional modality and prime for later recall of knowledge. If instructional designers create more opportunities for physical, embodied learning then students may be able to utilize more neural connections -via movement - to aid in recall of new knowledge.[9]

SMALLab
David Birchfield and the before mentioned Mina Johnson-Glenberg were a few of the first to research the concept of 'embodied learning' in relation to technology. Parallel to their research, they developed, with an interdisciplinary team, an embodied environment in which various sensors were used to record and feedback activity of children playing. This environment was called SMALLab: Situated Multimedia Arts Learning Lab. SMALLab was one of the earliest experiments with educational applications in which 'embodied learning' was used as a learning method. The SMALLab is now a regular teaching tool at the experimental QUEST school in New York.

9 Mina Johnson-Glenberg, David Birchfield

The research by Birchfield en Johnson-Glenberg showed that there were many opportunities and changes in developing new rich learning environments relating to embodiment. The introduction of new gaming controllers like the Wii-remote and the Kinect-sensors accelerated the process even more. Developing interactive installations is a slightly easier process by experimenting with the possibilities of embodiment in a technical application by using the developers' kits provided by, for example, Microsoft.

Waag Society formal education prototypes
To get more insight in the most effective ways of using embodiment in a formal educational situation and to experiment with the above-mentioned game controllers, Waag Society has initiated two pilots that deal with formal learning situations in relation to embodiment. Academic and design interns Nikolaos Poulios and Jelmer de Maat developed two rudimentary working prototypes of educational games. The games use mainly the interface and mechanics of the Microsoft Kinect. Both games focus on the development of knowledge in formal educational subjects: one in mathematics, the other in language development.

NumHop
Nikolaos Poulios developed the game NumHop. In essence it is a derivative of the playground game hopscotch. By using a variety of sensors the game calls upon various physical skills of the player while doing mathematical assignments. Besides the use of the Kinect sensor, we experimented with biofeedback in this application by using input from the Mindwave sensor, which is attached to the head of the player and can register levels of concentration. In NumHop the player answers a math question by jumping on a virtual square with the correct answer in it. The sums appear in a rapid concession, and the player has about four seconds to enter the correct answer. If the wrong answer is entered, or the reaction time was to slow, robots will appear to try and slay the player. But the player can also vanquish these robots by pointing a laser beam at them. This laser beam can only be created if the player is concentrating sufficiently.

Superhero Island
Jelmer de Maat was also asked to develop an interactive game-platform for children in primary schools. The platform was meant to improve both math and language skills in a playful and 'embodied' way. The prototype Jelmer developed could be considered a 'mini-game' on the platform and focuses on a specific language-skill: matching words. Children need to physically match two words with

each other. They do this by using their hands and 'grabbing' the words - and then connecting these by bringing both hands together. The prototype served as a starting point for an interactive Kinect-game in which all formal educational content could be integrated: Superhero Island.

Within the game-environment Superhero Island, teachers are able to import their own curriculum, tailored to every single child.

Each level, or 'mini-game', represents a different set of skills in formal education. Each of the educational skills is connected to a superpower to make sure that every child creates its own superhero. This enhances the motivation to excel in all levels - even if this means it targets educational skills the child dislikes or does not yet master.
Both prototypes were tested at various schools, with children between the ages of 6 and 12.

Teachers reported back that they could see a future in both prototypes and saw a dual application: for children who might struggle with language or math but that are very physical, it might prove the way to motivate them and it might make learning easier, and for children who are already doing well in both subjects but who lack physical skills or who need an extra challenge.

Superhero Island 2.0
In 2014 Mik Langhout, research and development intern for Waag Society's Creative Learning Lab, took a closer look at the prototype of Superhero Island and took it to the next level as his graduation project. He researched the possibilities of integrating the principles of learning strategies into the platform. Eventually, he designed the system to recognize the preferred learning strategy for a child and will adapt its content accordingly.

Embodiment and soft skills
In the Dutch educational system, but presumably in other places in the world too, there is a growing need for facilitations and tools to judge and support the development of social and emotional skills in students. Central to this need is the relation of the individual with his or her social environment, in which all possible modes of expression are supported. This includes social, pedagogical, didactical and psychological support for students during the development of skills for societal participation and group dynamics.

Waag Society: soft skills prototypes
Parallel to the research and development of 'embodied learning' tools for formal learning situations, Waag Society also experimented with two pilots, focussing more on the nurturing of 21st century skills, or 'soft skills'. Waag Society developed both sets of prototypes in light of the research consortium COMMIT, specifically in the pilot PLAY.

Mood Room
The first challenge was to develop an interactive environment in which adolescents (15 - 18 year olds) could learn social and emotional skills, in an embodied way. The goal was to give youngsters some handles to get to know each other, by first getting to know themselves. It is common knowledge that young people find it difficult to express their emotions in words, in a way that others might understand. Additional to this, most young people are not yet capable of showing empathy - comprehending other people's feelings and understanding their lives and choices. To properly be able to do this, one needs to understand his or her own feelings first.

These considerations resulted in an interactive projection on one to three man-sized screens that form a space in which these young people can use their body to 'talk' about their emotions. By using a new 'language', one that is based on sensory experiences and one that uses image and sound as representations of these experiences, youngsters are able to express their emotions without being hindered by semantics. And at the same time they are able to 'experience' other people's feelings without too many obstacles. The user is able to influence the content of the projection by controlling the visual (and eventually audio) representation by using his body.

Cylinder-Rolling Stairs-Seesaw
The second challenge was to develop interactive embodied objects where adolescents (15 - 18 year olds) could learn to develop a sense of collaboration, personal involvement, focus and creativity. In contrast to the prototypes previously described, Cylinder-Rolling Stairs-Seesaw is a series of physical balance objects, and works with different technology than Kinect sensor. Artist in residence Marloeke van der Vlugt developed these objects.

The three objects evoke body awareness and the interaction emphasizes the natural functionality of our bodies, like standing up, climbing, stretching and balancing, questioning 'regular' human computer interaction. All objects aim to be silenced by the performer(s), as silence is considered the ideal state-of-mind to focus on the embodied self.

Concluding: it feels good
We started with stating that, to us, 'embodied learning' is one of the most promising themes in ed-

ucation. Since we first started researching this topic in 2011 a lot of new developments and knowledge has arisen and we learned many things first hand by developing prototypes. And we have noticed that the education system is slowly, but steadily, getting ready for this new development.

The most important lesson we can take from our research and experiments is that there is still much to be discovered about the workings of our minds and bodies, and how they work together. But, besides this open ended conclusion, we can make some statements about were we stand on 'embodied learning'.

Even after a few years of research, 'embodied learning' is still a very new and complex field. We managed to partlyt lift the veil and were able to test some of our hypotheses.

We now know that the use of the body in both formal education and in the development of soft skills has an added value for the learning process. Though in the latter situation, it is still very difficult to definitively measure the effects.
We stated that there is distinction to be made between the 'sensory' and the 'motoric' experiences a body can process. In reality in no situation it is just one or the other. While the former usually is connected to the receiving incentives and the latter to the conscious actions, one cannot occur without the other. While acting, sensory experiences are naturally triggered. The best examples to illustrate this are the physical objects Cylinder-Rolling Stairs-Seesaw.

Though we consider 'embodied learning' a derivative or subsection of 'embodied cognition' we need to understand the cognition in order to understand learning - and they are in many ways two words for the same process in the neurosystem. The research in the neurological field, in relation to psychology, is therefore a new and very interesting domain to follow and to start experimenting with.

NumHop: Multi-Sensor Interactive Systems for Embodied Learning Games

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Abstract. This paper explores the use of modern sensor technologies for physical interaction in educational games and interactive spaces. The paper presents a prototype of an educational game developed using a motion capture controller and two biofeedback sensors (EEG, ECG), proposing a generic architecture for multi-sensor interactive spaces. Target of this research is to study further the potential effect of such technologies on educational interactive games, in two aspects: i) on the involvement of human body and motion in the process of learning, and recall of knowledge, ii) on assisting the development of basic social emotional competencies, through the enhanced social affordances of embodied games.

Keywords: multi-sensor systems, educational games, embodied learning, physical interaction, motion interaction, interactive spaces, affective interaction, biofeedback sensors

Introduction

The use of computer games in education has been an active field of academic research for the last twenty years, providing considerable evidence to support the positive effects of the use of games on the learning outcomes of students. Up until recently, based on the capabilities of the given technology, academic studies focused mainly on the conceptual engagement of learners in games. At the same time, scientists have highlighted the importance of psychological factors that influence children's learning, placing the development of social-emotional competences at the core of modern pedagogy, and creating a growing need in education for tools and instruments to support and assess these skills. Central to the development of social-emotional competences is the individual in relation to his or her social environment using all possible expressive forms. The human body can be seen as part of the human cognition (Dourish 2001 [1]), and a medium of self-expression and interaction with the environment and other people, thus its involvement in learning is of key importance.

The use of motion controllers and biofeedback sensor technologies has great potential for educational games, contributing to the conceptual engagement of learners [2], as well as to the social interaction affordances of the game [3]. Motion controllers, offer more freedom to move and to self-express, leading to an effective kinaesthetic experience. Additionally, body sensors, and their use inside game dynamics, provide us with an instrument to observe and quantify in real time, the reflection of our actions, or stimuli of the surrounding environment, to our body, physical and mental condition, helping us to understand ourselves better. For spectators who can monitor player's performance and physical effort, player becomes an active physical part of the game creating a theatrical atmosphere around his performance, the game's story and virtual environment. As players and spectators exchange roles, the overall experience leads to increased self-awareness and awareness of others.

This paper showcases a prototype developed during a study in the design of multi-sensor interactive systems for learning games. This study was conducted for the master thesis project of the author during an internship at Waag Society, institute for art, science and technology in Amsterdam, and as preliminary research for a project called the Embodied Playful Learning Theatre (EPLT). EPLT is meant to be a highly immersive environment, providing an open platform for research and development of applications and games featuring multiple sensor technologies. EPLT is part of the institute's involvement in the COMMIT P4[10], "virtual worlds for well-being" project. COMMIT is a large, nationwide program for innovation, bringing together leading research institutes and the high technology industry.

A prototype for a multi-sensor interaction physical learning game

Targets of the prototype presented were: i) the testing and demonstration of the capabilities of some selected commercial sensors, ii) the basic implementation of a multi-sensor system's, generic architectural design, and iii) to provide a base for the collection of some first body and motion data for further study of the concept of using these data in game interactions.

10 http://waag.org/en/project/commit

Inspired by simple traditional children's games like hopscotch or jumping rope, the main idea of the prototype conceptualized and developed by the author was to use a motion capture sensor to create a board game that would blend characteristics of such games, such as physical social interaction and bodily motion, with those of modern video games, like dynamic computer graphics, sound effects, and fantastic virtual environments.

The technology
The prototype uses the Microsoft Kinect sensor, the Neurosky Mindwave EEG sensor, and the Zephyr HxM ECG sensor. The selection of these devices was based on their availability as ready-made solutions, their technical specifications, their suitability to be used in a physical installation, and the level of support in the programming development of the game. Microsoft Kinect is a real-time motion capture sensor, which, based on an infrared depth camera and advanced computer vision algorithms, is capable of tracking at 30Hz the position of 20 joints of the body in space, for two players simultaneously. Kinect was chosen as a state of the art commercial motion sensor, an economic solution with previously proven performance and reliability.

Neurosky Mindwave is a wireless EEG based sensor, designed mainly to be used for games. The sensor uses a single electrode on the forehead of the player to capture voltage fluctuations in specific frequencies that have been related to brain activity, providing as output two values of "attention" and "meditation" that indicate the mental state of the player. An EEG sensor was chosen as new in commercial level technology, with promising features that would add novelty to the game, and intrigue the player. Mindwave was selected specifically for its ease of use in an installation, requiring short time to wear and calibrate, and the ability to maintain position and signal even under intense motion.

Zephyr HxM is a wireless ECG sensor placed near the chest of the player measuring his heartbeat rate. Heartbeat rate was chosen as a value that, in contrast with the EEG signals, all people and even children are quite familiar with, because large enough fluctuations are internally sensed. The visualization of the heartbeat rate, and the interaction based on it, creates another link between the physically sensed body, and the virtual environment, that will enhance the feeling of immersion.

The combination of these two selected body sensors creates a good first base to collect data and study possible indications of correlation of physical activity and mental state.

The prototype was developed using the Unity 3D game engine for the game, OpenNI SDK for communication with the Kinect Sensor, and cinder C++ library for communication with the other sensors, visualization and storage of the data collected. All game artwork was taken from Unity's community and example projects.

The Game – NumHop
In the final game prototype developed, named NumHop, the player is placed in a virtual large hall [Fig. 1]. In front of the player, on the floor, there is a board of 16 numbered tiles. The player is called to answer questions on simple multiplication matrices, for example the result of 6 x 7. The tiles of the board are numbered to values close to the correct result with at least one containing the correct number. The player then has some seconds to select his answer by stepping onto a tile. The faster the player responds correctly, the more points he gains. If the player does not respond, the game moves automatically to the next question. If, on the other hand, the player selects a wrong answer, the board moves to the next question, and an enemy robot is teleported in the scene through one of the 6 chambers, and starts approaching the player with bad intentions.

The player can defend himself against the robots by activating his "superpower beam" (activated by raising both hands above shoulder level) and direct it against the robots. The player starts the game with a certain level of superpower that it is reduced by use. When, however, the EEG sensor that the player wears on his head, detects a high level of attention, the superpower level starts to charge and the player can use it again. If the player runs out of superpower, he has to suffer the robot's hits, which reduce the player's health level. If the player survives the attack he can step back for a moment and try to relax. When the EEG sensor detects high level of meditation, the health level of the player is increased. The player is given 3 lives in the beginning of the game, and bonus lives are awarded after a number of consecutive correct answers.

The heart rate value is not directly connected to any element of the game play. There are two reasons that led to this decision. The first one is that because the heart sensor has to be moisturized a little and worn under the player's clothes, it might prove to be impractical, and time consuming to use in a school test session. The second one is that designing a certain interaction based on heart rate, and mapping this to a crucial element of the game, requires to know in advance the expected range of values during the game; knowledge and expertise that was not available at the time of development.

The presence of the heart rate value however was thought to be useful as also explained earlier, first for collection of the data for further use, and second to see how players respond to this information. If for example, showing the heart rate value of the player by making it appear on the GUI, could be conceived by someone as another form of scoring points, this motivates the player to raise his heart rate by moving more intensively.

Multi-sensor interactive system architecture
NumHop prototype was developed following a design pattern that demonstrates a generic architecture for multi-sensor interactive spaces, such as the Embodied Playful Learning Theatre project. As described in the introduction of this document the EPLT is meant to be an open platform to be used by developers, artists and researchers for experimentation, testing and support of multi-sensor interaction technologies. As such, the EPLT should feature a flexible, extendable and scalable architecture that can be adapted according to the application built upon it, and the equipment used.

Based on the above system requirements, characteristic of the proposed architecture is the separation of the system and its interactions in three levels. The first level is the world level including the physical setup of the installation, the sensor devices used, and the various output devices of the system, such as projectors, sound and lighting systems.
The second level is the device level, describing low-level hardware and software acting as middleware, responsible for the collection and transmission of data coming from the various sensors to the application, and other sub-systems controlling the output mechanisms used by the application.
The third level, the application level corresponds to the system accepting data from the sensors as input and process them to the corresponding output.
Components composing the different parts of the device and the application level can correspond either to processes running on the same computer, or processes running distributed over a network, each one implementing a different part of the interactive system. In order to provide this flexibility, a common messaging service is established between the two levels.

Following this architecture, NumHop consists of two applications, the game itself developed in the Unity game engine (C#), and a second one, developed in cinder (C++) library, implementing the device level. That second application is responsible for the connection with sensor devices, the collection, over time visualization, and permanent storage of the sensor data, along with the transmission of those data to the game engine. The two applications communicate using the Open Sound Control (OSC) protocol. OSC features include URL-style symbolic naming, high-resolution numeric argument data, pattern matching language to specify multiple recipients of a single message, high-resolution time tags, and "bundles" of messages whose effects must occur simultaneously. Due to its flexibility and simplicity, OSC has become an "industry standard" in the field of interactive installations, and has been implemented in a lot of programming languages, real time multimedia processing software and hardware, sound and light consoles, and various tangible interfaces. This makes OSC an ideal solution to be used in the system's middleware, as it allows the use of sensors, even with applications and devices used by non-programmers. Another advantage of this scheme is that it allows the deployment of an input control system that makes it easier for the whole system to handle and recover from errors. Errors like sensors losing contact with player's body, or dropped connections, are easier to diagnose by monitoring the data collected, outside of the game, and if possible, to restore normal function without interruption.

Conclusions – Further study
The experience of a preliminary evaluation of the prototype (12 participants, 20-40 years old) showed us that these technologies add a certain level of novelty to the game, triggering people's curiosity and offering and engaging experience. On the negative side, it also showed us that even in a simple game, designing interactions based on multiple sensors might lead to some degree of difficultness to understand game mechanics.

Previous studies in the field of sensor technologies and affective interaction have found various real-time modalities and bio-signals that reveal information about the emotional state of a person. Expanding this research and integrating those findings in games, will allow us to work towards more ambient forms of interaction, where sensor data is not directly mapped to certain actions, but used by an adaptive game environment and virtual actors with basic signs of emotional intelligence. Elements like these would enhance the immersive experience of an interactive story, with robustly interactive characters, that by extension would help the player to express and control her own emotions.
This paper was previously presented at the Advances in Computer Entertainment Technology International Conference (ACE) 2013.

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This paper was previously presented at the Advances in Computer Entertainment Technology International Conference (ACE) 2013.

Superhero Island 2.0 - Embodied Learning and Learning preferences

Mik Langhout - graduate artificial intelligence

Introduction
Waag Society focuses on Embodied Learning; how the body, not only the mind, can be involved in learning processes. Kinect is a possible technology used for developing installations that involves bodily actions as a prerequisite for learning.

SMALLab Learning (2010) inspired Waag Society's Creative Learning Lab. SMALLab's definition of embodied learning is: "Embodied Learning is an emerging field that blends the learning sciences and human computer interaction. Cognitive scientists have discovered compelling evidence that nearly all of our experiences are in some way grounded in the body. This suggests that the embodied experiences can lead to more effective learning."

In neuropsychology and educational practice, there is a transition happening regarding the main perspective of how we learn. Cognition is not only a product of the mind; it is a product of the interaction between mind and body. Within this context Waag Society developed a prototype, called Superhero Island, in which the body is involved as an interface in the learning process by the use of sensor technology of the Kinect. According to Waag Society, Embodied Learning can be seen as the means to justify the versatility of children in their learning process.

Superhero Island 1.0
The concept of Superhero Island, developed by Jelmer de Maat, is meant to provide an Embodied Learning application for formal education, which can be math, language or subjects like geography. The game setting of Superhero Island aims to provide a playful learning environment for children, in which learning seems like a by-product of play.

The concept is called Superhero Island and is an educational game package. The island is an environment where the children have their own superhero, whom they develop by playing little games on the island. While playing the games, not only do the superhero's skills and appearance develop, but the children themselves develop in the educational field. Because the game uses "movement in learning" principles, the children learn the material better and/or faster, according to the hypothesis of embodied learning.

The first prototype of Superhero Island is about language, more specifically: matching words.
It consists of an 'underwater' level with words in 'bubbles' that hover over the screen. By moving the hands towards each other a child can connect the words with a semantic relation, like 'banana' and 'yellow'. The test results indicated that children, 6-8 years of age, read easier and after recognizing the words they could also link them semantically. And, that, being able to move in a playful way, the game was highly motivating for the children.
The game is still single player but during testing the other pupils formed an active enthusiastic audience. In this way, teamwork is already possible.

Goal
During my internship at Waag Society, I was asked to develop an updated and more extended concept for Superhero Island. I am personally interested in 'learning styles'. Why only differentiate content regarding the degree of difficulty? Why not differentiate content regarding the form in which it is presented and the possibilities of how we can interact with it?

SMALLab Learning's definition of Embodied Learning, in which nearly all experiences are grounded in the body, suggests that learning is dependent of our experiences. Since we all have different experiences, you could state that we all learn differently.

From this perspective Superhero Island 2.0 utilizes the child's learning potential, and it provides insight for the teacher and the parents about a certain learning strategy of the child. Above all it triggers the intrinsic motivation of the child to learn playfully.

The goal I set for Superhero Island 2.0 was to differentiate by means of 'learning preferences'. The idea is that the resulting interaction patterns between a child and the game can state something useful about how a child learns effectively. Subsequently, the system can adapt itself by dynamically switching between different forms of content and interaction, associated with a certain learning preference.

Learning preferences
My concept is based on Fleming's theory of learning styles (2001-2013). Fleming's claim is that you can

have multiple learning styles i.e. visual, auditory, kinaesthetic, read/write in which there is mostly one dominant.

Educational systems that try to diagnose learning styles often do this by means of a questionnaire. This 'assessment of learning' seems not very appropriate, because a learning style is changeable and very context dependent. Having one fixed learning style is declared a neuromyth. To justify the dynamic nature of learning, 'assessment for and while learning' seems more appropriate. Within this article, 'preference' will be used as appropriate term because, compared to the notion of style, a preference is less fixed.

The aim is for children to benefit from this synergy creation, where technologic means allow for a continuous involvement of the diversity in learning, making each pattern of user-system-interaction input for research and inspiration for (re-) designing didactics and educational content.

Contemporary perspective on Embodied Learning
To elaborate the spectrum of Embodied Learning, we need to know its bandwidth before we can tune to its wavelengths.

Embodied Learning explains the concept of learning by means of how the body, and not only the mind, is involved in the learning process. The body has eyes to see, ears to hear, a mouth to talk with or to make sounds, arms to move in different directions and hands to point, touch and grab with, and of course legs and feet to stand on, walk, run, dance and kick. Visual, auditory and tactile sensory inputs and different motor outputs each relate to a specific modality in the brain, which enable us to act within the environment and to form a perception of the world.

Action-Perception-Cycle
Since body and mind are intertwined, our actions continuously alter our perception, which in turn trigger specific motor parts of the brain that afford new actions in and perceptions of the world.
This action-perception cycle has no start or end; it forms neural circuits with feed-forward to and feedback from associative memory and higher mental processes. The 'next' sensory input will find its way by activating these neural circuits and thereby form a representation of 'what is out there'.

Rambusch & Ziemke (2005) describe embodiment as the link between cognition and the action-perception-cycle. Embodiment is about conceptualization and thought resulting from bodily interactions with the world and therefore cognition is grounded in sensorimotor activity. Like Merleau-Ponty before[11], they plea against mind-body dualism and behaviourism i.e. thinking as a result from doing and visa versa. Instead, they plea for a co-occurrence of doing and thinking.

Top-down and Bottom-up processing
Top-down processing is about how personal goals and preferences of body and brain can direct attention to specific sensory inputs. These goals and preferences influence the conditions under which we learn i.e. how neural circuits are formed and activated. The conditions under which neural circuits get formed, determine the conditions under which these neural circuits get activated in the future. This principle is known as state-dependent learning.
Bottom-up processing is about the sensory experience of an object or event and its modality-specific features i.e. visually, auditory, tactile or a combination of them. These features are the reasons that sensory inputs attract attention in the first place.

The collaboration between top-down and bottom-up processes results in semantic integration, in which sensorimotor coupling between modalities allows for further meaning processing in multimodal areas of the brain. As explained earlier, this is accomplished by feed-forward to and feedback from associative memory and higher mental processes.
Rambusch & Ziemke (2005) view higher mental processes as a function of meaningful mediated activity. This activity (or experience) can be mediated by other people's behaviour, by material tools and psychological tools like language, which is similar to the psychological toolset of Vygotsky[12].

11 Merleau-Ponty (1908-1962) explains embodied experience and cognition from a biological, rather than a mental, point of view: "the body is intentional in itself and perception is really a motor act". This viewpoint goes against dualism and in a sense also against behaviourism, since there is no distinction between the observable and unobservable. Being, in this sense, is a matter of bodily experience in which the body is the centre of the process of action and perception, and the brain is 'just' a part of the whole system. He also considers language the process of thinking and not merely a verbalization of thoughts.

12 Vygotsky (1978) describes language as a psychological tool for thoughts, feelings and behaviour, which makes language a mediator for higher mental functions. Since languages enable us to assign meaning to everything around us both in time and space, he states: 'language liberates us from immediate perceptual experience'. He also puts forward the term internalization, which is about the transition from the way we communicate with others to the way we communicate with ourselves, like inner speech, respectively known as inter- and intrapersonal communication.

Experience
Kontra et al. (2012) view embodiment as fulfilling memory's most fundamental purpose: to store and recall experience. Like the action-perception-cycle, the storage and recall of experience in memory are an on-going process, in which neural circuits are successively formed, triggered and reformed. Each experience is recognition of what is known, a representation of someone, something, somewhere, somehow, and the opportunity to act and change the environment and reconsolidate memories.

Experience is the derivative of embodiment and has a rich context and multisensory character. The versatility of experience serves as an enacting process for cognition and behaviour to occur interchangeably i.e. like a catalyst for the action-perception-cycle. Higher mental processes are the derivatives of experience, in which understanding arises from grounding a concept in sensorimotor regions of the cortex.

Experiment
Individual differences in learning preferences can be seen as a child's learning potential. Most existing educational software applications for learning language only differentiate in level of difficulty regarding content and not form, which is the learning approach itself.

Complementing or challenging learning preferences provides a new view on 'personalized' learning in both content and form, in which Kinect gaming data can provide dynamics of the learning process. But how?

To research learning preferences of children that learn language, an experiment was performed at primary school de Poseidon, in which words in text were presented together with different forms of content.

In this experiment I made a serious attempt to find embodied learning preferences in practice. By means of a PowerPoint simulation I attempted to show a proof of concept of my idea to incorporate an intelligent system adapting to learning preferences in Superhero Island 2.0. My approach is comparable to this 'Wizard of Oz' experiment, in which the subject has interaction with a computer system that is actually controlled by a human being.
My experiment clearly indicated that children learn differently, although it turned out very hard to actually measure actual and perceptual learning preferences (in detail). I aimed at recognition of learning preferences in a linear way; by means of analysing gaming data from a separate learn cycle and different test cycles for each modality. Once the learning preference was recognized, applying them would consist of adaptation regarding multisensory content and future interactions.

Initially, the idea was that a child could then learn 'more difficult' words by adjusting multisensory content to its dominant embodied learning preference, for example visual and articulatory, and use 'less difficult' words to stimulate the child's other embodied learning preferences like acoustic, auditory and kinaesthetic.
However, the experiment has taught me that learning and testing naturally overlaps and that learning preferences are extremely subject to change. Next to children's developmental phases, learning preferences seem to depend on personal experience and intrinsic motivation relative to the content, game and system design.
Furthermore, the experiment has taught me that offering multisensory content is most valuable when a child can not yet read a word or does not know its meaning.

Superhero Island 2.0
Superhero Island 2.0 first needs a fundamental game structure containing different levels, and degrees of difficulty. The target group is formed by children of 4-7 years of age, aiding in the transition from toddler to primary school. This is the phase in which children start learning to read.

Normally children start reading according to the lexico-semantic route, in which the lexico part regards the textual characteristics of the word, including orthographic (visual), phono-acoustic (sound) and phono-articulatory (speech) modalities. The lexico part is followed by the semantic part, which is about the meaning of the word.

Superhero Island 2.0 emphasizes on the meaning of the word by means of stimulating imagination and invite curiosity. The goal is to read and understand the meaning of the words, not merely to remember them. This entails addressing both short- and long term memory, because the word in text needs to be linked to semantic mechanisms in the brain that together with higher association areas provide meaning for it. These focus points are relevant both for language development and deepen linguistic knowledge.

Within Superhero Island 2.0 the aim is to introduce a broad spectrum of Embodied Learning, in which the action-perception-cycle is stimulated by means of multisensory content and multimodal interaction possibilities. When a child cannot read a word in text, the 'normal' lexico-semantic route could be reversed to a semantic-lexico route, in which the meaning of a word precedes (and possibly enhances) the textual interpretation of the word.

Ideally, the form of content and interactions should be tailored to a child's learning preferences, by varying all the possible in- and outputs within the gaming environment regarding sensory and motor modalities. Embodied learning preferences could provide insight in a child's development and enable to focus on specific parts of a child's development.

In the design of Superhero Island 2.0 we aim to incorporate an intelligent system for the recognition and application of embodied learning preferences, where the end goal is to be able to answer 'how is a kid smart?' rather than 'how smart is a kid?'.

Multisensory content
Superhero Island 1.0 was about Embodied Learning by means of matching words in text with the movement of your hands. Superhero Island 2.0 introduces an Embodied Learning language game with multisensory content. Words in text are presented together with spoken words, sounds and pictures. If a child recognizes a word, there are different possibilities for the act of understanding; say, sound, gesture, move or even sing. The interaction in the game is playful en encourages movement.

Learning preferences
While playing, the system stores the link between the recognized word and associated perception and action(s) of understanding of that word.
When progress shows, for example when a child significantly scores better with pictures, the system adopts visual as a dominant learning preference. The subsequent game play can be adapted in either preference mode or inverse preference mode, to respectively play with either more or less pictures, to either complement or challenge a child's embodied learning preferences. The same holds for spoken words and accompanying sounds. The act of understanding is also stored, for example when a child does not move a lot while playing the game, the interaction of the game should encourage movement.

The prototype of Superhero Island 2.0 will be presented by the end of 2014.

Mood Room: playing with emotions

Compilation of texts by:
Bennie Mols - science journalist
Marise Schot - concept developer Waag Society
Meia Wippoo - concept developer Waag Society
Laura Buijs - psychologist

To explore the possibilities of 'embodied learning' in relation to the development of social and emotional skills in young people, Waag Society developed the Mood Room. The goal with this project was to give young people some tools to understand each other, by first getting to know themselves. It is common knowledge that young people find it difficult to express their emotions in words, in a way that others might understand. In addition to this, most young people are not yet able to show empathy, to comprehend other people's feelings and understand their lives and choices. To properly be capable to do this, one needs to understand his or her own feelings first.

The Mood Room is an open physical space in which (young) people can express their emotions by using their bodies. It is an interactive installation that records bodily movements with a Kinect-senor and translates these movements into colours, patterns, vibrations and sounds. The visual content is projected on three screens in front and around the user. The initial prototype uses various abstract visual representations. With that we have designed a new 'language' of different movements, in which the participants can express and communicate their emotions better than in words. It is our ambition to add on other sensory experiences. The fist addition will be sound and music.

As a result the Mood Room allows young people to 'talk' about their emotions by using their body. By using our new 'language', one that is based on sensory experiences and one that uses image and sound as representations of these experiences, young people are able to express their emotions without being hindered by semantics. And at the same time they are able to 'experience' other people's feelings without too many wordy obstacles. The user is able to influence the content of the projection by controlling the visual (and eventually audio) representation by using his body.

The Mood Room functions in line with the principles of embodied cognition. It recognizes the mutual influence between our body, senses and cognitive functions. One aspect of this is communicating about emotions through visual cues, like colours and patterns.

Leading up to the Mood Room

Before we designed and built the prototype of the Mood Room, we needed to know a little bit more about the effects and workings of emotions and sensory experiences. In different tests we explored the phenomenon of 'sharing experiences' regarding the development of empathy with small groups of prospective users. In the 'Map Your Mood' test we asked the participants to share experiences using colours, music, the Plutchik emotion wheel, vibrations and smells.

In 'Connecting Though Experiences', which was the second test, we asked the participants to make a common avatar, using magazine images to represent their experience. In the test that followed, 'How are you today', we invited the participants to express a feeling that they recently experienced. They were given two options of expressing these feelings: either by creating their own wall, making use of different materials like paint, wool, straws, etc. and secondly by intuitively composing vibrating, colour patterns and selecting suitable music in a virtual environment.

The aim of the tests was to discover how people could convey an experience best to create understanding with others. Overall we noticed that abstract elements supported an experience better than concrete elements. For example; in the test 'Map Your Mood' participants shared their experiences of their first kiss. While using smell, colour and textures all other participants could easily understand the situation and could relate to it by matching them with their own experiences. In the third test, when participants were asked to use paint and wool to express important experiences the results seemed to be more cliché, and therefore less personal and thus distant.

It seemed important to the participants to share their experiences in a safe environment. One participant told us that using materials and colours offered a lower threshold than words for sharing her experiences. We also found that participants did not feel safe when they had to 'build' a shared experience together since they had to negotiate about feelings and emotions.

Another interesting finding was that most participants needed to have experienced a situation themselves before they were able to recognise the experiences of others.

In a nutshell, to share experiences people need to have experienced these themselves in some way to be able to recognise them. It does not have to be the exact experience but at least something relatable. With that in mind, different senses need to be addressed to communicate the richness of the experiences, and figurative representation needs to be avoided, as it doesn't truly affect others. It's too general and too obvious.

Users in the Mood Room

We conducted usability tests in cooperation with psychology graduate Laura Buijs. In this research, the effectiveness of the interactive installation was measured on the empathy level of the users, teenagers between the age of 14 and 17 years old. For this purpose they had to visualize six basic emotions by using the installation.

The teenagers were asked to express these emotions by selecting and manipulating colours, vibrations and patterns in the installation. In addition, we conducted a qualitative study to assess the impact of the installation on the participants.

Expected results were that the level of empathy of users that portray an emotion would rise. Also we expected that emotions would be represented as described in the literature surrounding embodied cognition. We conducted the research among 63 teenagers, all from high schools in Amsterdam.

The results of the qualitative study show that the participants were surprised that it was possible to convey an emotion in this way, with colours and patterns. One of the participants said:

'When I read the invitation, I really thought it would be a stupid idea. But it's really cool! It's great that you guys have proven that this is possible.'

In order to be able to intuitively operate the system (rather than in a cognitive manner), it was important that the participants were sensitized. A variety of factors could influence the impact of the tool: the personal history of the participant, the presence of background music or a quiet versus hectic environment could all play a part in the interpretation of the visuals. In addition, it proved easier for young people to portray their emotions if they could name them afterwards.

Although all the participants expressed their emotions in their own way, without any exception others could still recognize them. For participants who knew each other well, this was easier: they knew each other's background and stories already. For the people that didn't know each other, the installation provided insight into the other person:

'I am learning a lot more about him. I did not know he was so sad.'

Most participants would like to have the results on video, so they could take them home. One girl said:

'I would like to show this to my parents.'

Even though the added value of the installation was not immediately obvious to everyone, all the participants found it pleasant and fun to do. In particular, the new and original elements of the installation were appealing.

The quantitative study of the tests shows that the level of cognitive empathy in participants who observed the users in the installation did increase, compared to the levels before the test. This effect was also noticeable by the users of the installation themselves, but did not increase further during the test. The effect was enhanced by the family situation of the teenagers: those from a family with divorced parents had a higher level of cognitive empathy compared to those whose parents were still together. This effect was only measurable while observing participants.

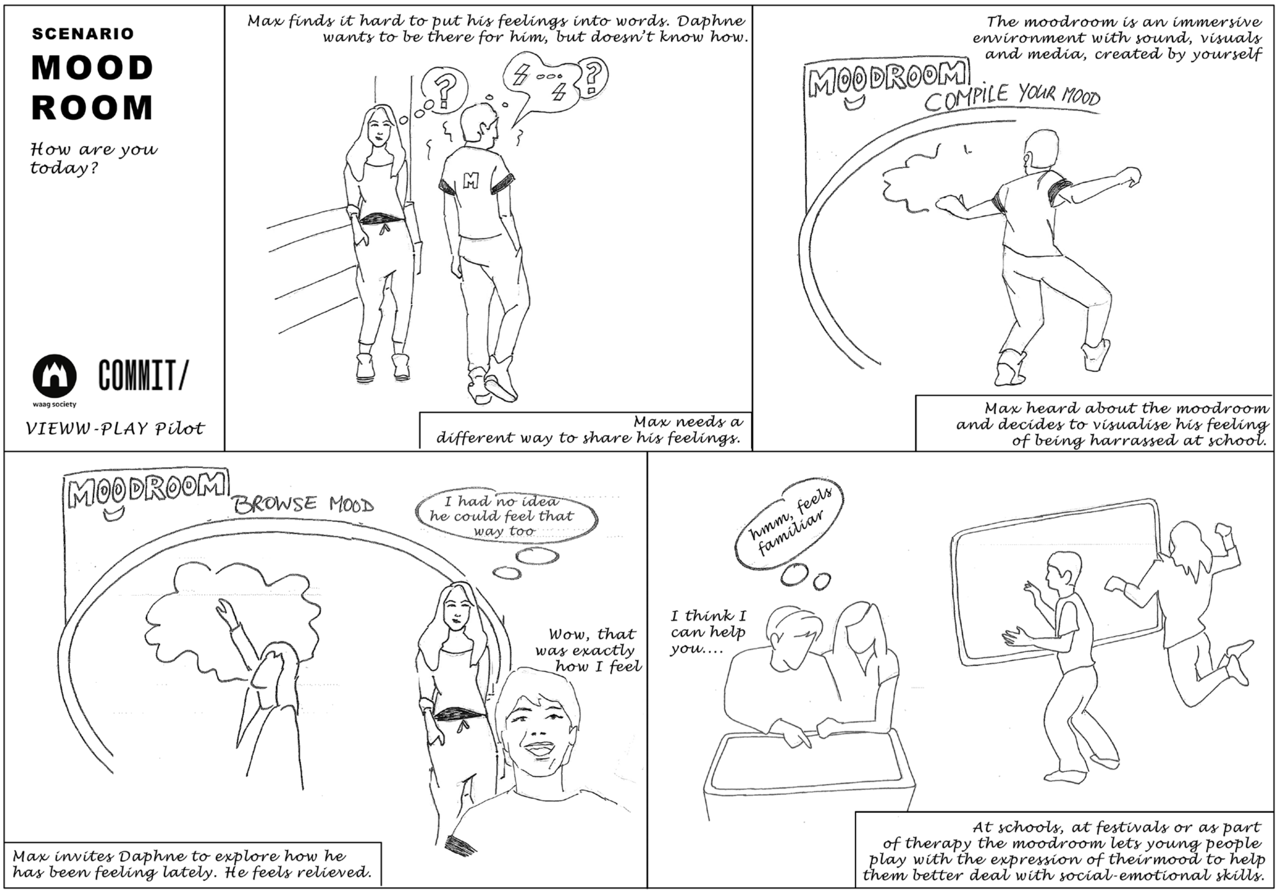
The full research report (in Dutch) can be downloaded from waag.org/commit.

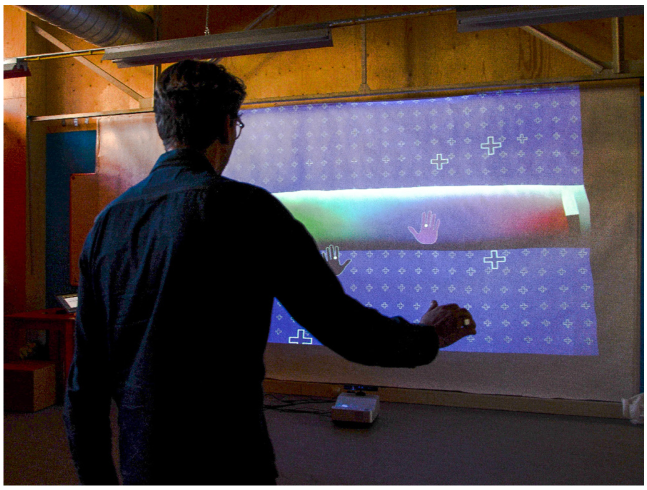
Future endeavours

In the follow-up to this research the emphasis will shift to teenagers with problems, the development of a secure environment for users and the role of observant in the installation. We intend on cooperating with Bascule (a psychiatric institute for children, teenagers and young adults) to explore the possibilities to integrate the Mood Room in some of their therapies.

In other therapeutic situations, for example while rehabilitating after a stroke or injury, the Mood Room could function like a diary to record the recovery process in relation to the emotional health of the patient.

The installation could also have a place at festivals and other informal places where people can interact with each other. Visualization can have a more public function. The application can have a function both in communication and in empowerment.



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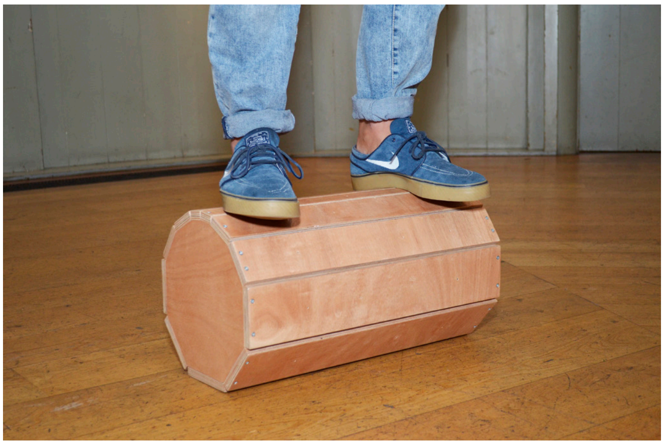


Cylinder-Rolling Stairs-Seesaw

Marloeke van der Vlugt - artist in residence

Introduction
I create performative installations that research what it entails when the embodied self gets extended, hybridised and delimited through technologies. My work seeks manners to transcend the natural borders of the body through physical interaction with sensory devices. Often the body itself becomes a kind of interface.

In my interactive installations I make use of strategies originating in the domain of 'performance' and 'intermedial theatre'. The visitor / participant is invited to alternate the position of performer and spectator enabling them to unveil, sense and discuss actual emerging body concepts. "In contemporary performance and theatrical practice we find an actualization of (and ways of dealing with) the bottleneck scenarios that are envisaged by information experts."[13].

The body concepts my work addresses, are difficult to catch in words. They are dynamic processes based on personal and corporal interaction of the participant with newly created technological platforms. These concepts are triggered and (sub)consciously formulated individually and on the spot.
The way to explore them is to engage oneself physically. Starting from this personal experience, critical questions about bigger themes like Identity, Human Enhancement, Communication and Social interaction, all in relation to technology, can – as a result of the interaction - be addressed from a personal perspective.

Research Embodied Learning
The installation Cylinder-Rolling Stairs-Seesaw was created during an artist-in-residency at Waag Society - in cooperation with Kennisnet[14] - as a result of the assignment to develop a challenging interactive installation for educational purposes. The work should enhance embodied learning of youngsters with the focus on '21th Century Skills'. These skills include collaboration, personal involvement, focus and creativity[15].

13 Quote Rob van Kranenburg
14 January – August 2013
http://www.kennisnet.nl/over-ons/international-visitors/about-kennisnet/
15 The focus in contemporary education is mainly on cognitive skills. There is an increasing need to pay more attention to soft skills, an open learning attitude and awareness of learning.

I started my artistic research with the question how 'soft skills' like collaboration, personal involvement, focus and creativity, could be triggered through the use of one's body. I first defined the following hypothesis about embodied learning, based on findings from my previous works:

Embodied learning is generating knowledge by using the body. This knowledge becomes effective when 'the learning itself' (through the interaction with the installation) incorporates direct feedback that stimulates physical awareness and generates time and space to critically reflect about the whole process.
Critical reflection and physical awareness both relate to the concept of embodied cognition.

What is embodied cognition?
Embodied cognition is dynamic. It's the acquisition of nonverbal knowledge encapsulated in our physical body (including our heads!) that is constantly influencing how we live and appreciate our lives. It's the (un) conscious personal knowledge we all accumulate through the years because we have a sensitive body, are social beings and are part of the world.

It's that what makes ANY of us special and unique while no body is the same.
Our embodied knowledge is always in flux while it consists of various processes constantly influencing each other. To name three: the sensation of the body: tired or active, adrenalized or down, ill or healthy. The shape and tissue of the body: short, tall, thick, thin and its posture. The (esthetical) appearance of the body: age, sexuality, and provenance.

These dynamic processes continuously interact with our subjectivity consisting of memories, associations, physical stimuli and ontological assumptions about the world around us.

To identify - and maybe clarify - this dynamic, personal knowledge it is useful to discuss the difference, according to Merleau Ponty, between a 'natural and unnatural' approach to the world. With a 'natural' approach to everything around us, we assume that objects have no meaning and we need to give them meaning. This process of 'giving meaning' is conditioned by the world we live in based on the ocular chirurgic scientific view or the dominant view in Western Society.

The unnatural way of perceiving is the opposite: to live in the world and physically sense what meaning the surrounding objects already have. Then we use our corporality to assemble a personal unconditioned approach[16]. An approach tied to concepts of originality[17] and creativity.

"What is important is not just that we have bodies and that thought is somehow embodied. What is important is that the very peculiar nature of our bodies shapes our very possibilities for conceptualisation and categorization."[18]

Or in other words, we are and we have a body. We can experience something and at the same time look at it from a distance. This ability we have is the very peculiar nature of our bodies: our embodied cognition.

The term Corporal literacy - for me –ties this 'natural and unnatural' approach together, because the concept of corporal literacy describes the abilities of the body to perceive, critically read and make sense. Corporal literacy is, in other words, 'bodily-meaning-making'.

Consequently: corporal literacy supports the execution of embodied learning[19].
Critically engaging with ones body stimulates an open unnatural approach to the world resulting in creativity and emphatic social behaviour.
If I train myself to listen to my body communicating to me, I can try to decipher how memories, associations and emotional assumptions are colouring my perception, how these are influencing how I take in and combine information and what my verbalized conclusion is based on.

16 Paraphrasing Maurice Merlau Ponty, L'Oeil et l'Esprit, 1964, read translation by Rens Vlasblom, Oog en Geest, Parresia, Amsterdam (2012)
17 Being, in this sense, is a matter of bodily experience where the body is the centre of the process of action and perception, and the brain is 'just' a part of the whole system. Paraphrasing Maurice Merleau Ponty, L'Oeil et l'Esprit, 1964, read translation by Rens Vlasblom, Oog en Geest, Parresia, Amsterdam (2012)
18 Lakoff and Mark Johnson. Philosophy in the Flesh. The Embodied Mind and its Challenge to Western Thought. Basic Books 1999: 19
19 Corporeal literacy does not simply mean the transposition of a language related concept to the realm of the body, but rather a rethinking of the notion of literacy from a position beyond oppositions like language and the body.' (Maaike Bleeker)

To give a few straightforward examples: I notice that I am tired, so I take a rest or a less active role like an observing role. His leg jumps up and down; let's get his attention by asking his opinion. I sat down in pure concentration but in a wrong posture, so it's not the material I am negative about but I need to sit up straight. I feel judged, while I put on the 'wrong' t-shirt, is it the cloth / material or the voice of the media that is prickling me?

Our (incorporated) knowledge can come to use by listening to our body and consciously interact with it. Then it is possible to find a personal way of engaging with new information in a manner of which is proven that it stimulates better understanding and beholding of information: evoking a state of being in the here-and-now, with focus and complete attention.

So there is need to create an environment in which body awareness is evoked and can be diagnosed by the student. The tools should be there to bring the body in an ideal situation to actively and personally engage with the offered tasks.

Design requirements
How to create an environment in which body awareness is evoked and can be diagnosed by the student? Or, in other words: what (technological) interactive tools stimulate 'corporal literacy'?

After doing more research (literature and practical), I compiled a list of requirements for the design of the installation:
1. Haptical interface (touch, resistance, balance): required to engage oneself physically, triggering an inquiring attitude[20]
2. Physically challenging with distinct learning curve (reference to 'handicraft': development of concentration and endurance[21])
3. Developing a corporal consciousness (like what posture do I have?) through feedback and reflection
4. Deepen the understanding of our social interaction and being part of a network
5. Enabling personalised and 'natural' interaction with technology; its functionality can be changed by its users (open platform)

20 Touch, force feedback and balance (or the somesthetic functions) are more important than sight or hearing in the perception of our own body. Somesthesis is critical for normal human functioning at many different levels, from controlling the body to perceiving the environment, as well as learning about and interacting with it.
21 The electronic information you can get everywhere is frictionless – to cope with craftsmanship creates bodily and mental friction, taking reflection back to the body. I aim to evoke this friction, while it asks for endurance, concentration, focus.

6. Triggering power poses[22]. To do a power pose for two minutes changes how we feel and think of ourselves.
7. Equipped for educational surroundings (safety, costs, sturdy, easy to install, ergonomics). Can the installation be used as furniture? Maybe installed in an auditorium?

The installation Cylinder-Rolling Stairs-Seesaw (CRS)

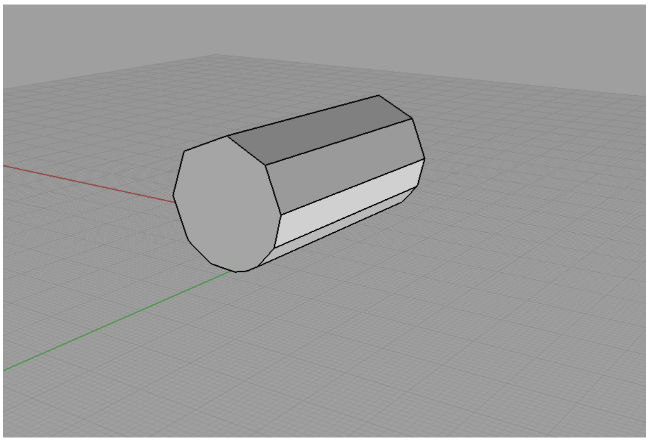
The installation evokes bodily awareness, 'corporal literacy', which can be diagnosed and personalised by the 'performer'. The interaction emphasizes the natural functionality of our bodies, like standing up, climbing, stretching and balancing, questioning 'regular' human computer interaction. All objects aim to be silenced by the performer(s), as I take silence as the ideal state-of-mind to focus on the embodied self.

The technology gives a feedback loop that stimulates the participant to explore his relation with his own body through interaction with the objects.

Comparing the prototypes of CRS with other devices, using the body as an interface like Wii Fit Plus, the feedback loop is unique. The participant is not only focussed outwards, towards the screen, but CRS constantly leads the focus back to the sensation of the moving body itself.

Let's look at the Cylinder. The participant steps on the Cylinder and finds his balance. Only then the 'game' will start. Standing on the Cylinder, the participant moves his body to make the graphical figures 'dance' on screen. His focus is drawn to the screen; the Kinect camera reads his movements. At the same time, the participant shouldn't step or fall off the Cylinder. Thus the Cylinder 'asks' the participant to focus on his moving body, the shape and the incorporated sensors define the maximum space for balancing and movement.

The CRS explore the idea of 'natural interaction with technology' through incorporating different senses and body parts. This is very important - especially for educational purposes - while current cognitive science shows that intellect for instance is dependent on perception and bodily movement. The evidence supports an evolutionary view in which reason uses and grows out of such bodily capacities.



Cylinder 2013, Okoume Multiplex, Milling machine, 25 x 50 cm Accelerometer, light sensors, audio device, speakers, Kinect camera, monitor, Mac Mini, video-camera

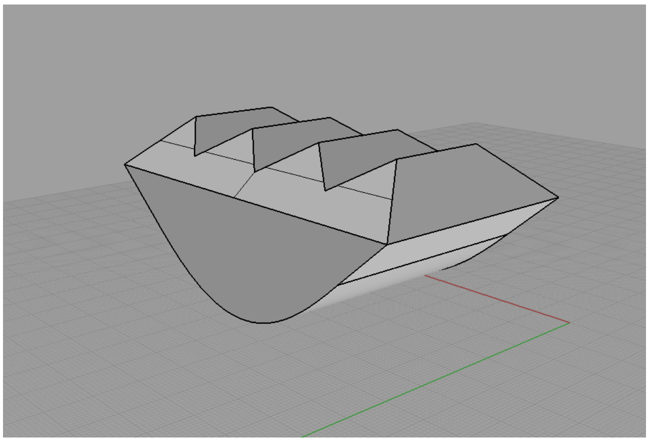
Goal

Empowering Tool. Interaction is focused on finding balance. The participant discovers the sensation of grounding the body while making different power poses like stretching up, holding these poses for a certain amount of time. The purpose is to 'quiet down' both physical interfaces meaning body and object.

The idea of making power poses, is based on the findings of Amy Cuddy. She discovered that our non-verbals not only influence how other people think of us but also govern how we think and feel of ourselves. Our bodies change our minds. To do a power pose for two minutes changes how we feel and think of ourselves. It changes our stress levels (cortisol) and our hormonal level (testosterone) making us more laid back and not stressed.
Cylinder and Kinect camera are programmed to trigger loud mumbling noises when 'the performer' is not standing in the desired position on the object. When standing and moving in the right manner it quiets down. Finishing all levels is 'rewarded' with the showing of video images of the participant, recorded while interacting with the cylinder, which can be used for many other 'learning purposes'. These real time video images of the performer are shown on the monitor in front of him / her, mirroring the performativity of perception[23], imprinting the images in the flesh.

22 http://www.ted.com/talks/amy_cuddy_your_body_language_shapes_who_you_are.html

23 Performativity of perception: how perception actually produces what appears as the object of our perception

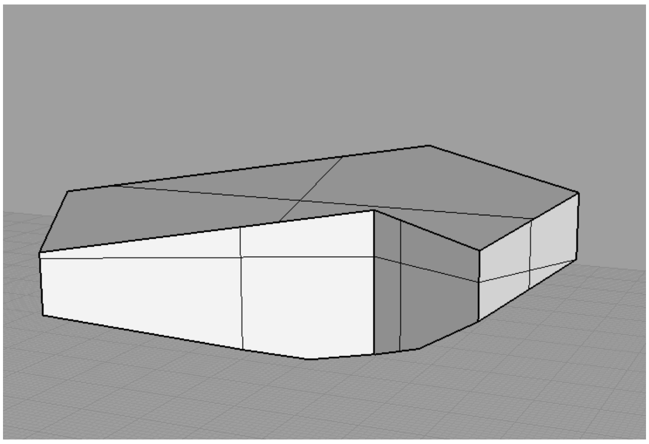


Rolling Stairs (2x), 2013, Okoume Multiplex, Milling machine, 48 x 100 cm, Accelerometer, Mac Mini, speakers

Goal

- Exploration of collaboration. Interaction is focused on 'balancing' between three phases in / types of collaboration;
- Helping each other
- Leader – follower reacting to each others position (mirroring)
- Working together towards a mutual goal (musical composition)

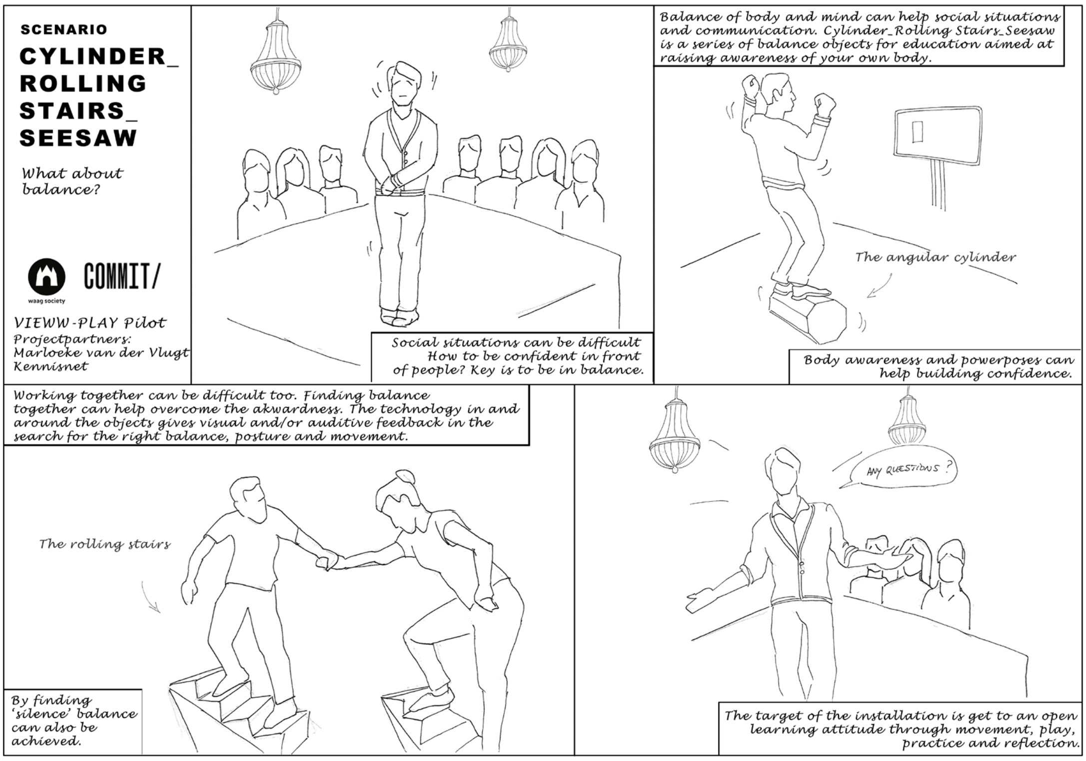
The purpose is to 'compose' with both physical interfaces (bodies and objects). The Rolling Stairs are programmed to trigger single notes or parts of melodies. Collaboration may lead to melodic lines, rhythms, musical compositions and finally silence as the ultimate composition ('4'33', silent piece by John Cage).



Seesaw, 2013, Okoume Multiplex, Milling machine, 89,7 x 32,4 cm Accelerometer, light sensors, Mac Mini, speakers, Kinect camera, video screen

Goal

Exploration of unbalance. Interaction is focused on unbalance by exploring asymmetrical movement, acceleration and / or extreme slowing down. The Seesaw is covered with light sensors. By closing one sensor, its audio sample will stop. Every turn, new combinations of sensors need to be closed using different body parts or even another body. During each spell of silence, a photo is taken showing unpredictable physical statues of oneself.



Experiences with Cylinder and Rolling Stairs at school

Madelief Keyser - programme manager innovation Kennisnet

Learn with open and committed attitude
The Partnership for 21st Century Skills (P21) states that today's life and work environments require far more than thinking skills and content knowledge. The ability to navigate the complex life and work environments in the globally competitive information age requires students to pay rigorous attention to developing adequate life and career skills. This package of skills we call 21st century skills, which are collaboration, creativity, critical thinking, ICT-literacy, communication, problem solving and social- and cultural skills.

Based on all conversations with experts about 21st century skills, Marloeke van der Vlugt concluded that the fundament of 21st century learning is about learning with an open and committed attitude which makes you more vulnerable to acquire new knowledge or learn a new task. This insight was the starting point for the further development of the installation.

Insight in personal learning styles
In the process of prototyping the installation students and teachers were involved. In April 2014, twenty-four 1st grade students of a secondary school in Enschede (Innova) tested the installation. The students were introduced in pairs with the installation without any explanation in advance. This open introduction with the installation identified several notable results that give input for further development.

In an empty classroom at a secondary school, Mark and Eva, two 1st grade students get acquainted for the first time with the Cylinder and the Rolling Stairs. They walk curiously around the objects. They give the rolling stairs a push and listen to the melodies that suddenly sound. Eva steps on the stairs and wobbles back and forth. A hodgepodge of sounds appears. Mark hesitates to follow Eva on the other rolling stair. Eva gives him a helping hand and accompanies him on the stairs. More melodies sound. Mark and Eva, standing opposite to each other on the stairs start to explore. How far can they go, when do they lose balance and what is the connection between the stairs and the melodies? Suddenly they hear a voice asking them to search for the same melody. The game starts, but it actually started already when Mark and Eva entered the classroom.

The behaviour that students show when they get acquainted with the installation provides insight in personal learning styles. This information can be valuable for the student and teachers or other facilitators in education.

Furthermore, first experiences show that students do find it difficult to connect their experience with the installation to their learning process. This holds them back from using the Cylinder or Rolling Stairs over and over again and is a process that should be guided or facilitated.

Learning to learn with the help of your body
The insights from the research that has been done and the impressions of students working with the installation give a first glance of how learning to learn (so called meta-cognitive skills) can be influenced by using your body and the direct feedback this generates. This installation stimulates further thinking and exploring the options of using your body as an interface in learning.

About Kennisnet
Kennisnet is the public educational organization, which supports and inspires Dutch primary, secondary and vocational institutions in the effective use of ICT. Kennisnet ensures that educational institutions are aware and take advantage of the opportunities offered by ICT. Research has shown that, for the use of ICT for educational purposes, a balanced and coherent use of four building blocks is essential. These blocks are: vision, expertise, digital learning materials and ICT infrastructure. Kennisnet facilitates the schools to achieve this. Barriers are removed and the strengths of the educational sector are bundled together.

Kennisnet was partner in the development of Cylinder-Rolling Stairs-Seesaw.

Colofon

About Waag Society
Waag Society, institute for art, science and technology, develops creative technology for social innovation. The foundation researches, develops concepts, pilots and prototypes and acts as an intermediate between the arts, science and the media. Waag Society cooperates with cultural, public and private parties.

Waag Society follows the method of Creative Research. Creative Research is experimental, interdisciplinary research. Artists, creatives and end users have a central position and a large influence on the final result: Users as Designers.

waag.org

About Creative Learning Lab
Creative Learning Lab is a research and development laboratory that wants to stay in close connection with the perception of young people and the wishes of teachers.

To answer our questions about the added value of IT and new media for education, we initiate small-scale projects in a direct cooperation with end users to develop prototypes and pilots. This kind of research is called practice-based research.

Within this research and development process we develop innovative learning environments and installations. We experiment with creative methods and technology. After this phase, a prototype can be made, reviewed and tested for its practical use and educational value. In the end, a next step in the development can be made towards a product.

waag.org/creativelearninglab

About Marloeke van der Vlugt
Marloeke van der Vlugt is a Dutch artist and researcher, based in the Netherlands. She graduated from the Faculty of Theatre in the University of Amsterdam and DasArts, the Amsterdam School of the Arts, receiving training in media and performance art. She worked as a choreographer, director and scenographer for various (inter)national theatre performances. Since 2006 she develops performative interactive installations in which the visitor replaces /becomes the performer.

www.marloekevandervlugt.com

About COMMIT/
The COMMIT program brings together leading researchers in search engines, parallel computing, databases, interaction in context, embedded systems and knowledge technology.

Aim of COMMIT is to broaden and enforce the Dutch knowledge infrastructure in ICT and to better position Dutch companies in international competition by connection the best scientists to hightech companies. There are 16 projects in which researchers of universities, technological institutes and businesses are participating.

www.commit-nl.nl

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